LEVEL II

TECHNICAL REPORT RL-80-8

FREE AIR PLUME OVERPRESSURE FOR 2.75 INCH ROCKET MOTORS MARK 40 AND MARK 66

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Testing was conducted to determine the free air blast overpressure of the 2.75 inch rocket motors MARK 40 and MARK 66. Data were collected for single and ripple firings of both types of rockets. "Pressure maps" were generated to display the results.

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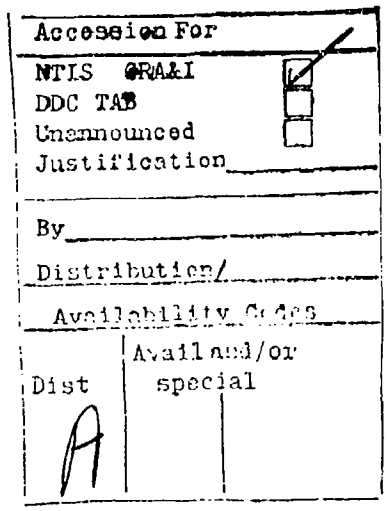

ILLUSTRATIONS

I. INTRODUCTION

Questions have risen for some time concerning the overpressure which is generated by launching 2.75 inch rocket motors. The US Army Missile Command was assigned the task to define the overpressure field which is created by both single and ripple rocket firings. Tests were conducted in October 1979 in order to generate overpressure data for two different 2.75 inch rocket motors. One of the rocket motors is the current Mark 40 (MK40) and the other is the Mark 66 (MK66) which is under development.

The US Navy is developing the MK66 rocket motor which has a higher thrust and velocity to achieve a longer range. The relative acceleration curves for both rocket motors are shown on Figure 1. The US Army is adapting the MK66 for Tri-service use which will allow launcher interoperability and improved accuracy when fired from a hovering helicopter.

Attack helicopter designers are concerned about the rocket motor plume overpressure levels because overpressure can affect aircraft design. The AH-1S TOW-COBRA was redesigned to withstand the blast overpressure of the TOW launch motor. Data generated in 1969 by Southwest Research Company under Contract No. DAAD05-67-C-0201 indicated a pressure of 6.5 psi on the helicopter tailboom. The purpose of the testing discussed in this report was to generate comparative data.

II. TEST SETUP

Testing was conducted at Test Area 1 of Redstone Arsenal, Alabama on 31 October 1979 (see Figure 2). Figure 3 depicts the test setup for the initial rocket firing and Figure 4 is an all inclusive diagram of the test setups for the various rocket firings. Instrumentation consisted of four temperature probes and four pressure transducers all of which were mounted on a "rake" and moved for each firing to establish the field for temperature and overpressure. During testing, the heat flux was too low to be recorded; therefore, temperature will not be discussed further. One pressure transducer was placed even with the front of the launcher and three feet off the center of the firing tube. The pressure transducers were the type which are used to measure sound decibels and then the decibels were converted into overpressure in pounds per square inch.

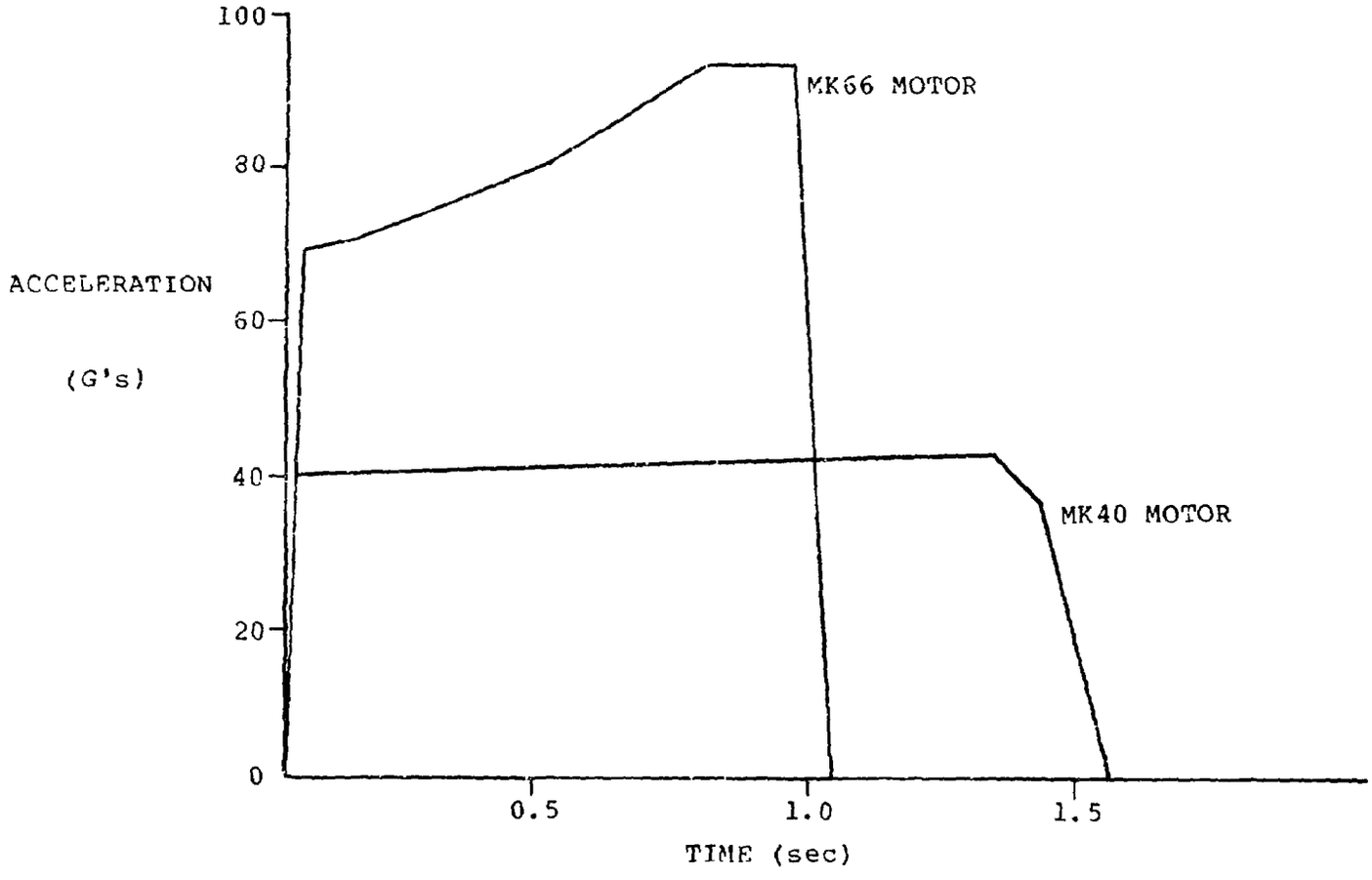

Figure 1. 2.75 inch rocket performance.

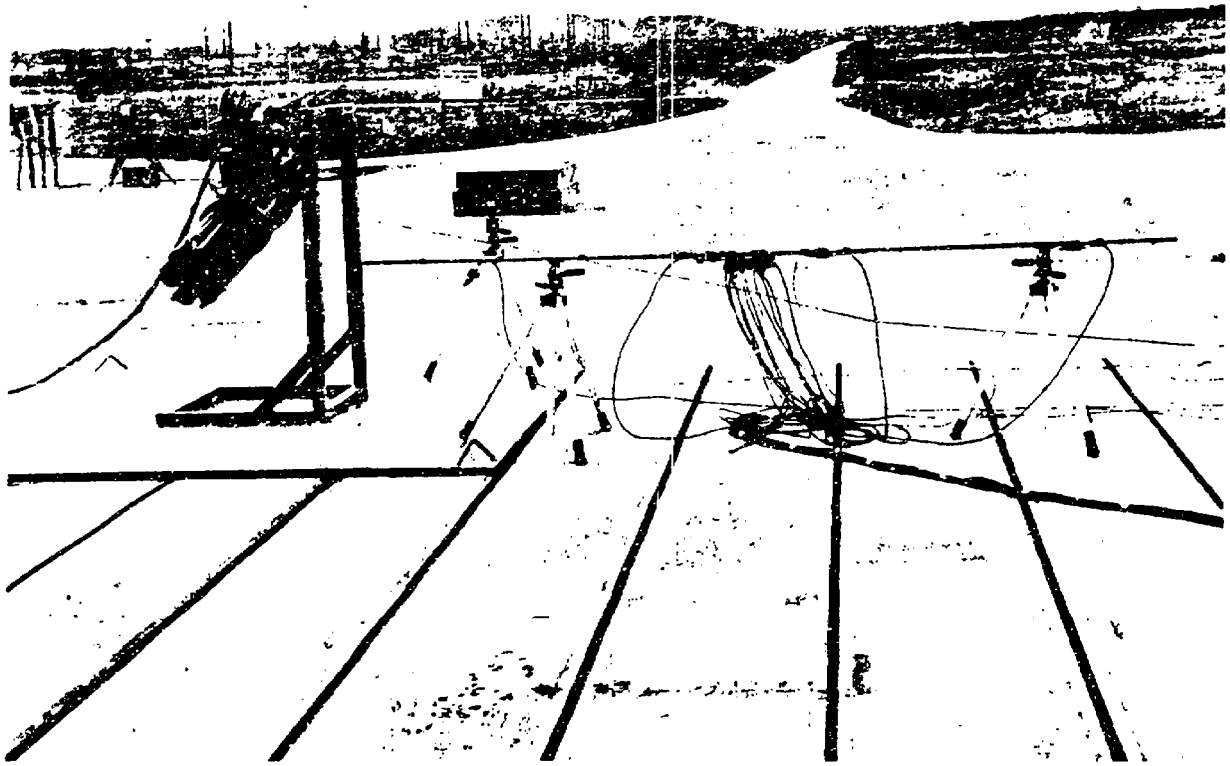

Figure 2. Test setup at test area 1.

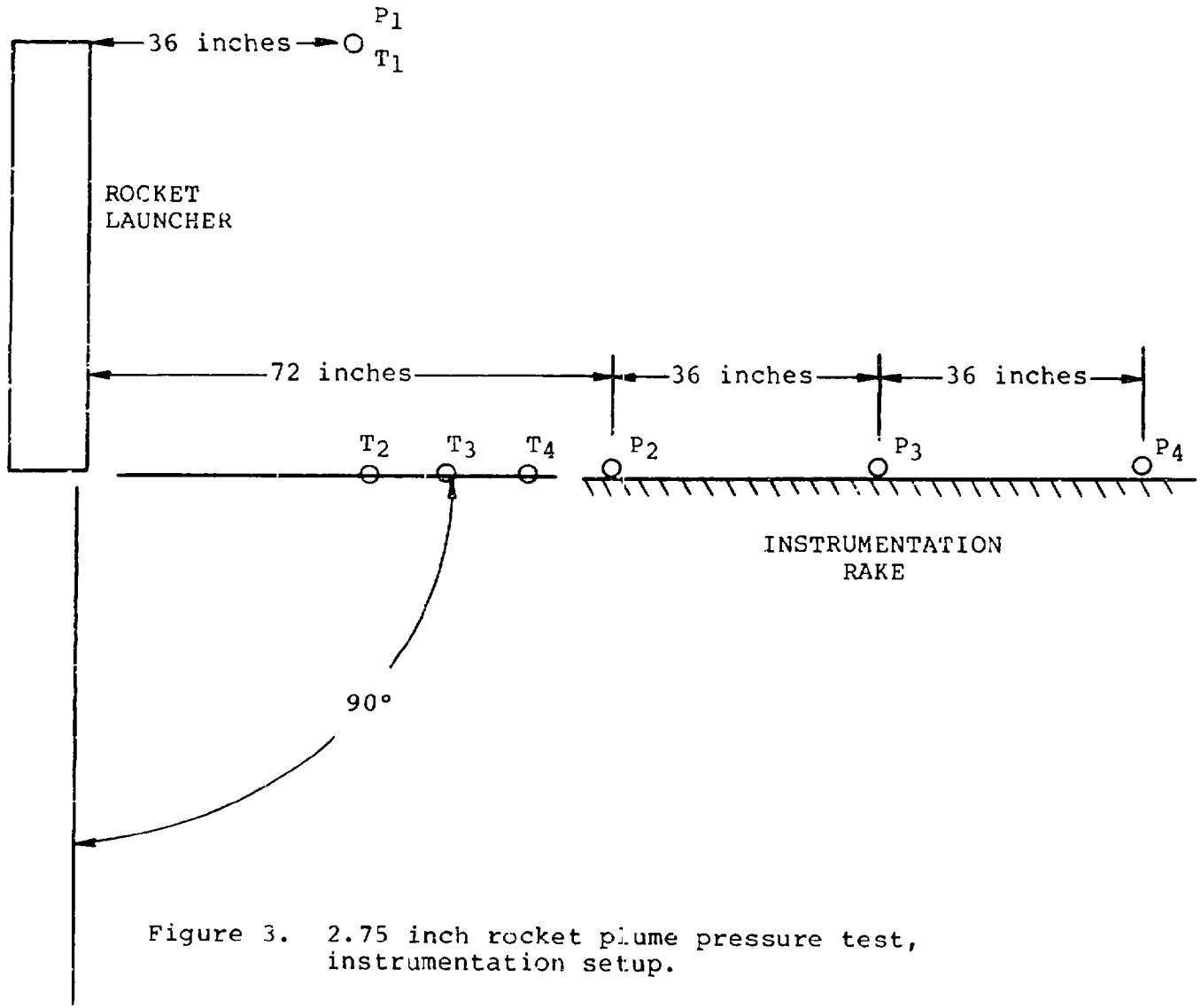

Figure 3. 2.75 inch rocket plume pressure test, instrumentation setup.

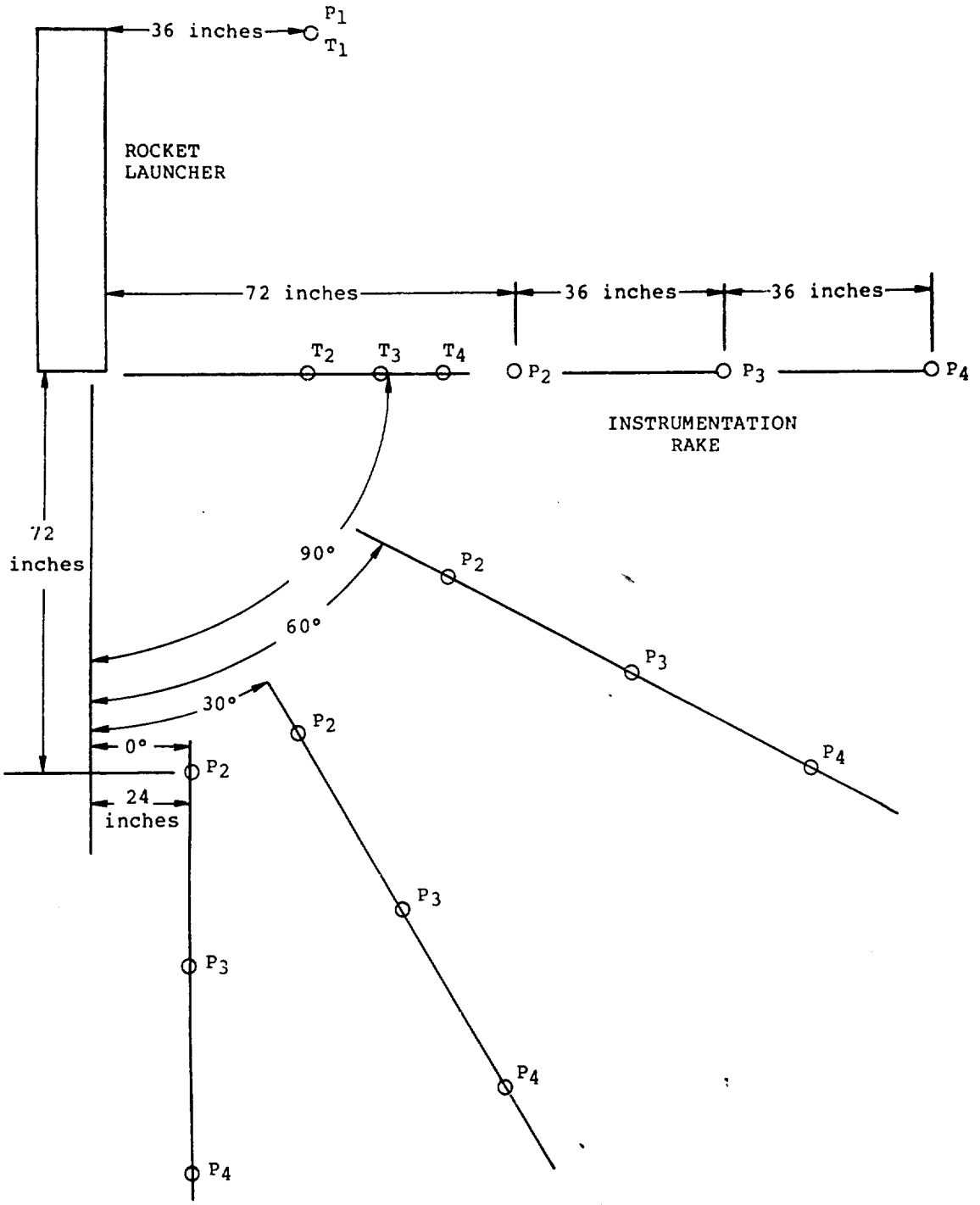

Figure 4. 2.75 inch rocket plume pressure test, single fire instrumentation positions.

Two launchers were used in conducting these tests. For single round firings the M-158A1, 7 tube launcher, was used and the M-200A1, 19 tube launcher, was used for ripple firings. A change was made between the M-158A1 and M-200A1 launchers to accommodate parallel testing; however, this change had no effect upon the results of the overpressure tests.

The MK40 rockets were fired using the standard firing contacts of both launchers; however, the MK66 rockets were slightly modified with "pig-tail" firing contacts. The "pig-tail" consisted of a length of 22 gage wire, a pushon sheet metal nut (trade name Tinnerman) and an AMP tap connector. The modification to the MK66 rockets permitted firings without modification to the launcher. See Figure 5 for the modification.

The launchers were mounted on a standard bomb rack which was adapted for ground firings. Rockets were fired at 15 degrees elevation to control the impact area.

III. TEST SEQUENCE

The test hardware was setup with the rake perpendicular to the line-of-sight, one MK40 rocket was fired to adjust the calibration of the pressure transducers, and all single round firings were completed first.

The testing proceeded as follows: The rake was moved back in 30 degree increments and one MK40 and one MK66 rocket was fired for each position. When the rake was set parallel to the line-of-sight, it was offset 24 inches from the launch tube center line to prevent damage to the transducers.

The rake was set at 45 degrees to the line-of-sight for the ripple firings. The first of two six-round ripple firings consisted of MK66 motors and the second of the MK40 motors. See Figure 6.

IV. TEST RESULTS

The pressure data acquired during the test is shown in Table 1. The pressure map resulting from the single MK40 firings is shown on Figure 7. The similar pressure map from MK66 firings is shown on Figure 8. Figure 9 shows the general pressure trace during the firing of round number 5 which was a MK66 motor. The quantitative values shown in Table 1 are peak pressures which occurred

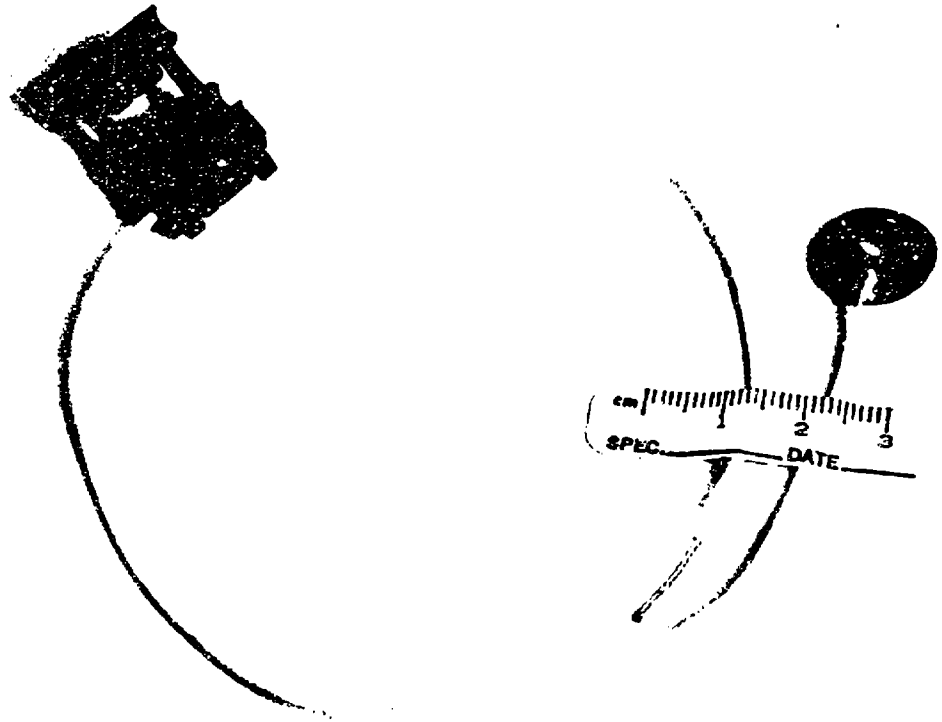

Figure 5. Firing adapter to permit use of MK66 rockets in M-200A1 and M-158A1 launchers.

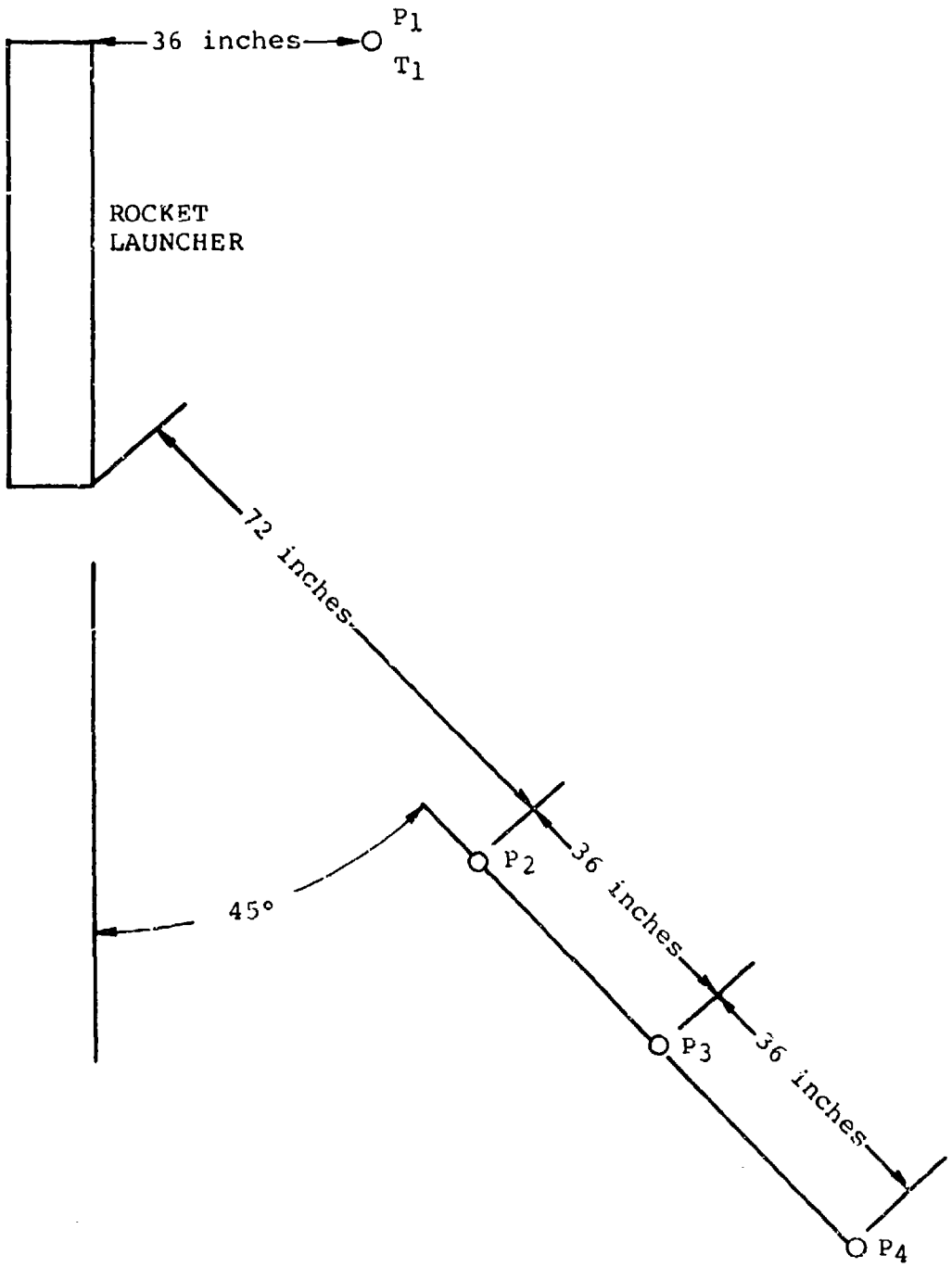

Figure 6. 2.75 inch rocket plume pressure test ripple fire instrumentation positions.

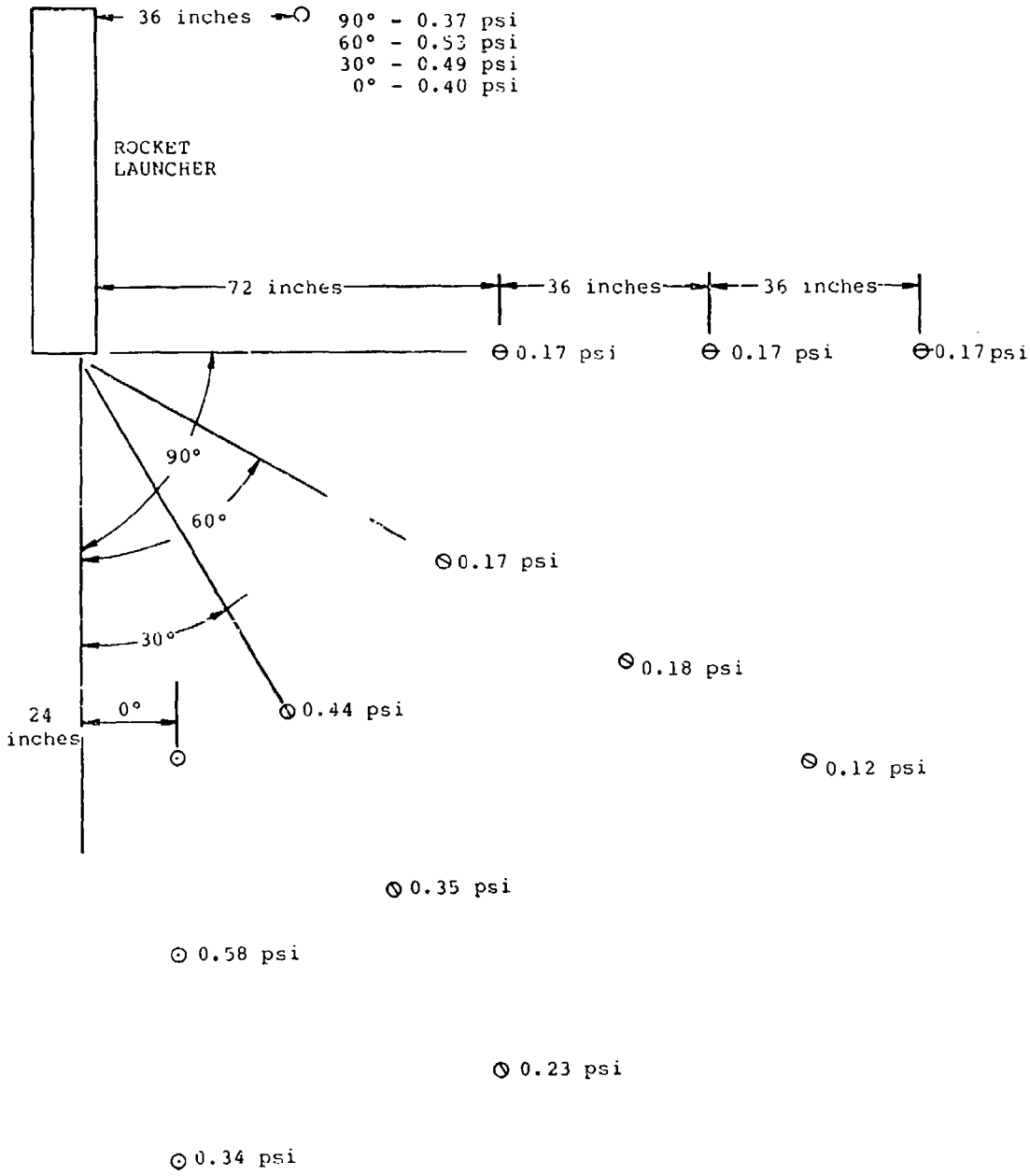

Figure 7. 2.75 inch rocket plume pressure test, MK40 single fire pressure map.

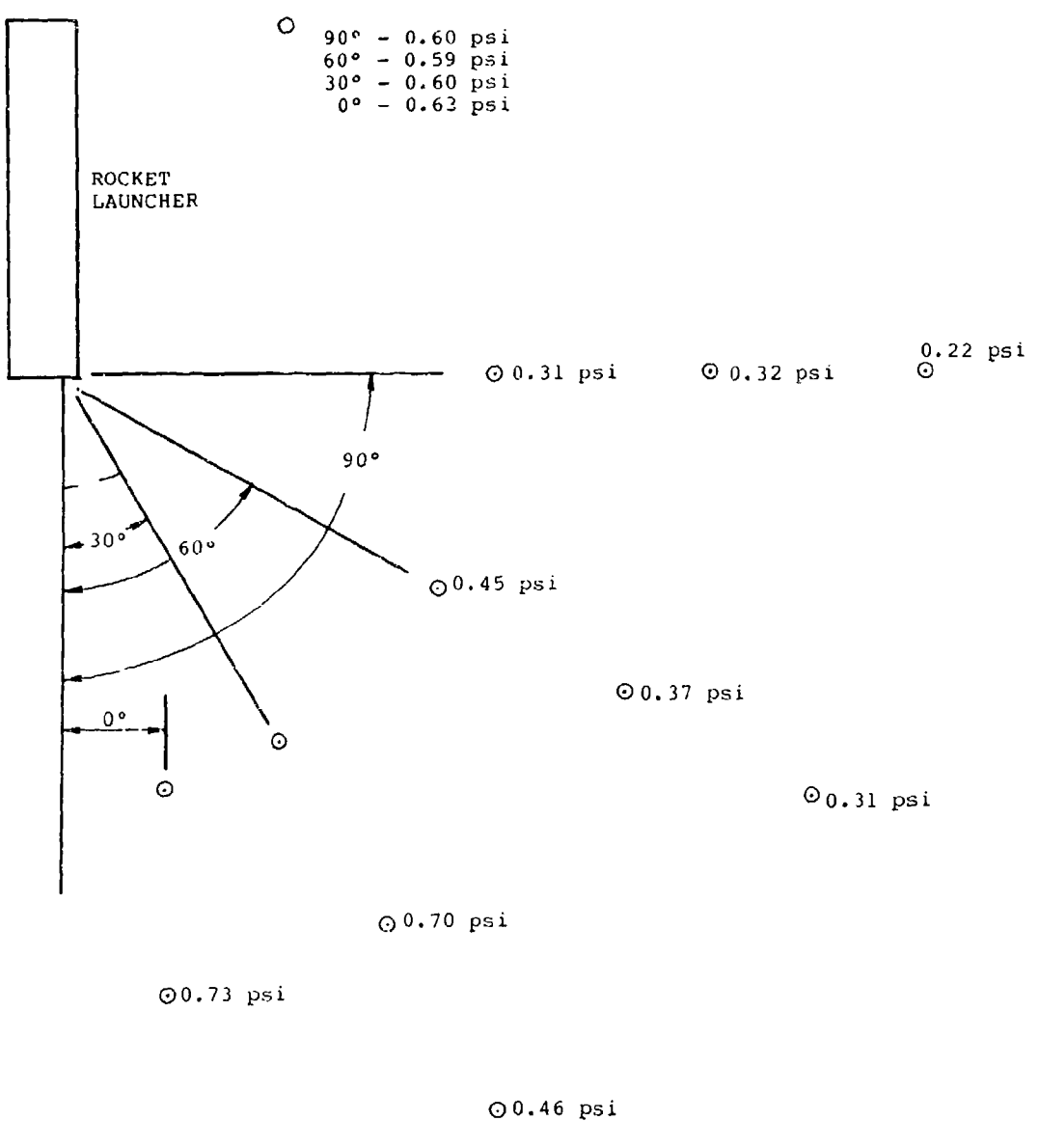

Figure 8. 2.75 inch rocket plume pressure test, MK66 single fire pressure map.

TABLE 1. MK40/MK66 ROCKET MOTOR PLUME PRESSURE TEST

ROUND NO.	ROCKET TYPE	RAKE POSITION (deg)	PRESSURE READINGS (psi) P_1 (FRONT)	P_2	P_3	P_4	TIME DELAY(P_1-P_2)
1.	MK40	90	0.48	0.18	0.23	0.18	0
2.	MK40	90	0.37	0.17	0.17	0.17	0
3.	MK66	90	0.60	0.31	0.32	0.22	0
4.	MK40	60	0.53	0.17	0.18	0.12	100 msec
5.	MK66	60	0.59	0.45	0.37	0.31	75 msec
6.	MK40	30	0.49	0.44	0.35	0.23	100 msec
7.	MK66	30	0.60	(1)	0.70	0.46	75 msec
8.	MK40	0	0.40	(1)	0.58	0.34	100 msec
9.	MK66	0	0.63	(1)	0.73	0.53	80 msec
10-1	MK66	45	0.58	(1)	0.62	0.58	80 msec
10-2	MK66	45	0.64	0.65	0.56	0.50	80 msec
10-3	MK66	45	0.43	0.54(2)	0.55	0.45	80 msec
10-4	MK66	45	0.54	0.51(2)	0.50	0.50	80 msec
10-5	MK66	45	0.54	0.68(2)	0.48	0.34	80 msec
10-6	MK66	45	0.48	0.59(2)	0.45	0.30	80 msec
11-1	MK40	45	0.35	0.48	0.38	0.31	100 msec
11-2	MK40	45	0.38	0.54	0.45	0.36	100 msec
11-3	MK40	45	0.38	0.43	0.36	0.36	100 msec
11-4	MK40	45	0.47	0.48	0.41	0.32	100 msec
11-5	MK40	45	0.35	0.44	0.43	0.36	100 msec
11-6	MK40	45	0.30	0.36	0.35	0.28	100 msec

Notes: (1) Maximum data points are difficult to measure.
(2) Basic data line was in sinusoidal excursions.

approximately 50 milliseconds after ignition as shown on Figure 9. The peak pressures are virtually instantaneous and the trend of the pressure profile is below that of the peak pressure listed.

Figures 10 and 11 show the pressure readings from the MK66 and MK40 ripples respectively. The ripple rate was nominally 167 milliseconds (msec) so the pressure trace from one rocket would decay before the next rocket pressure would be recorded.

It should be noted that the highest overpressure observed during these tests was an order of magnitude less than the overpressure produced by the TOW tests.

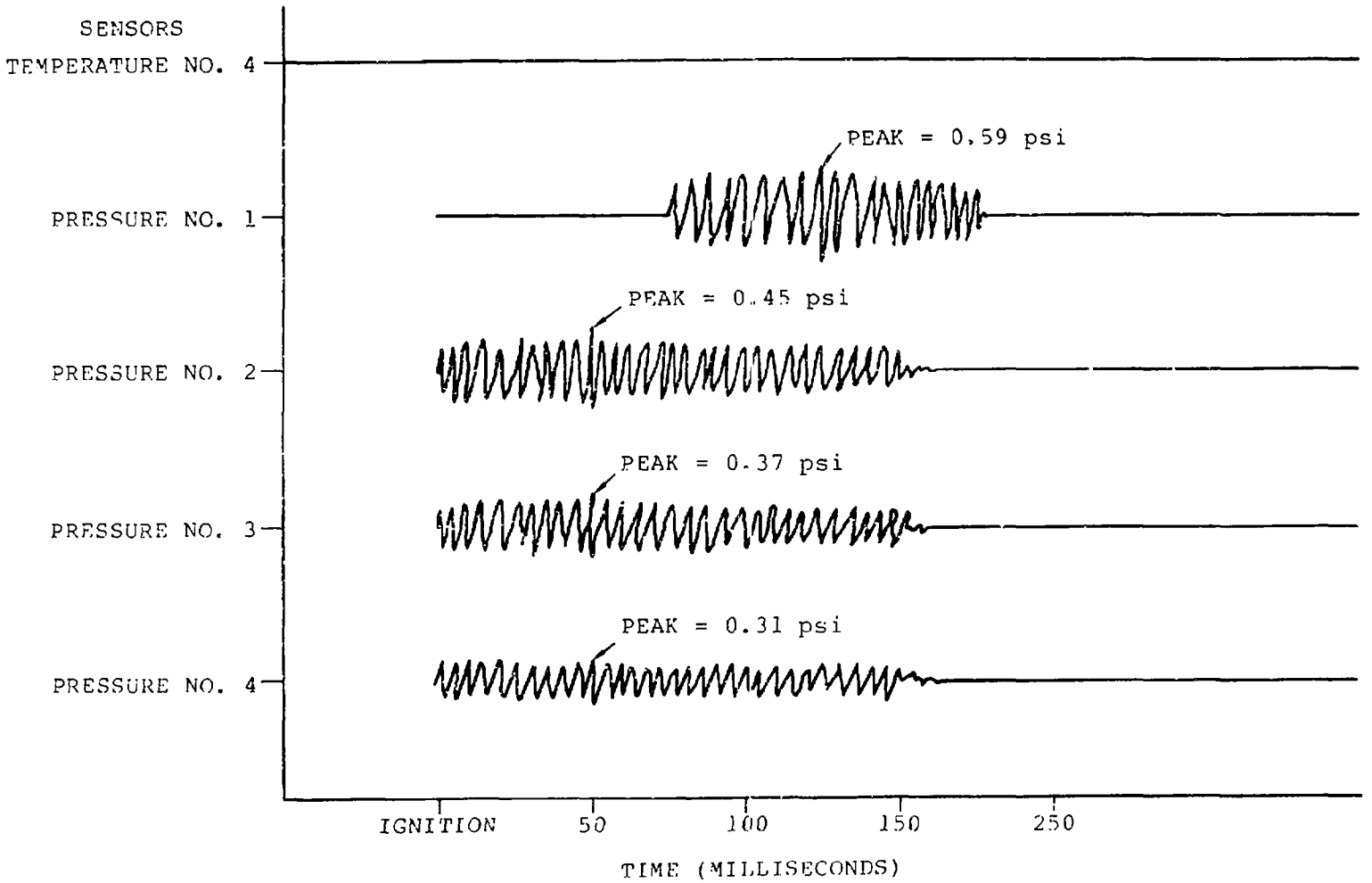

Figure 9. 2.75 inch rocket plume pressure test, round No. 5, MK66 motor.

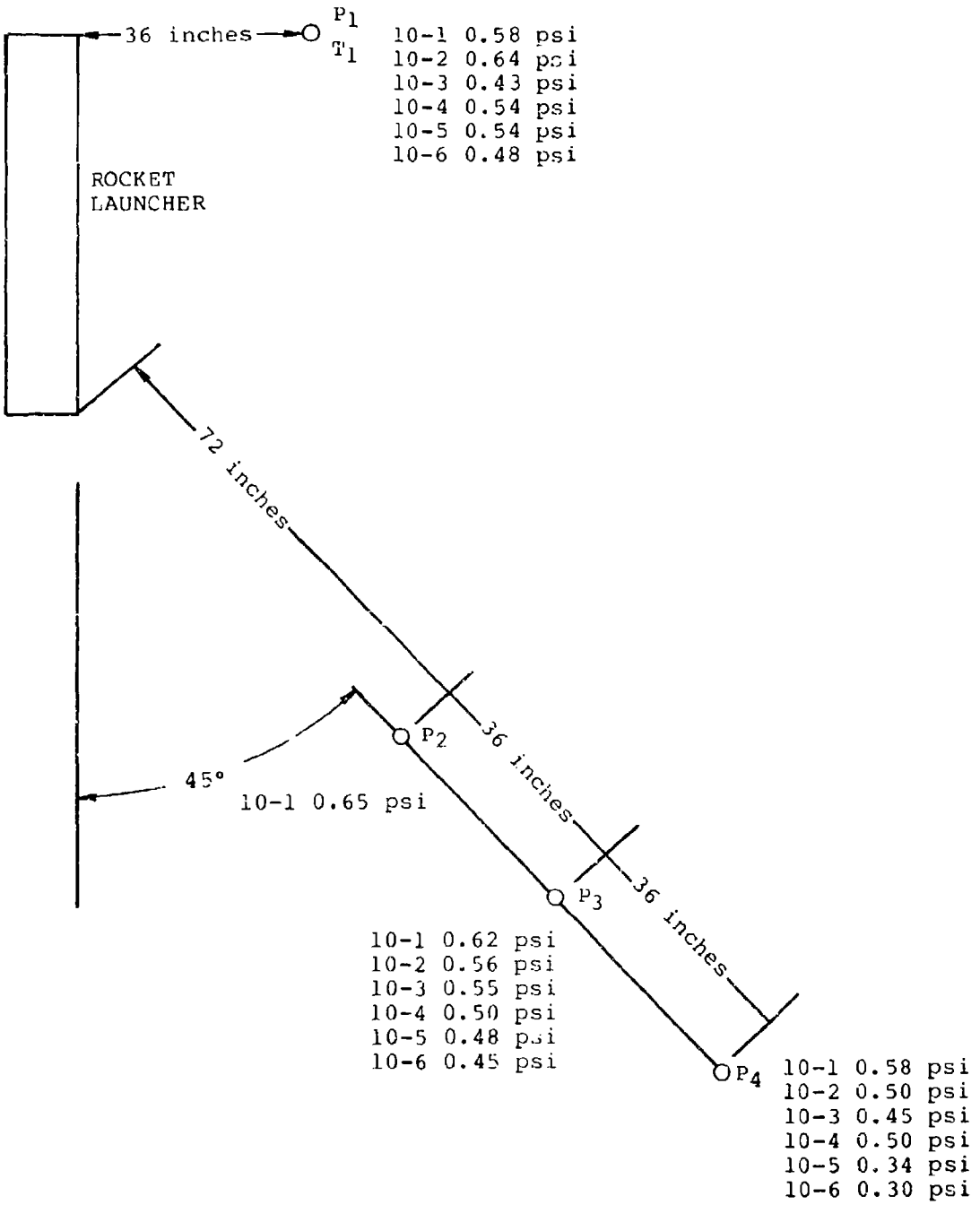

Figure 10. 2.75 inch rocket plume pressure test, MK66 motor ripple fire pressure map.

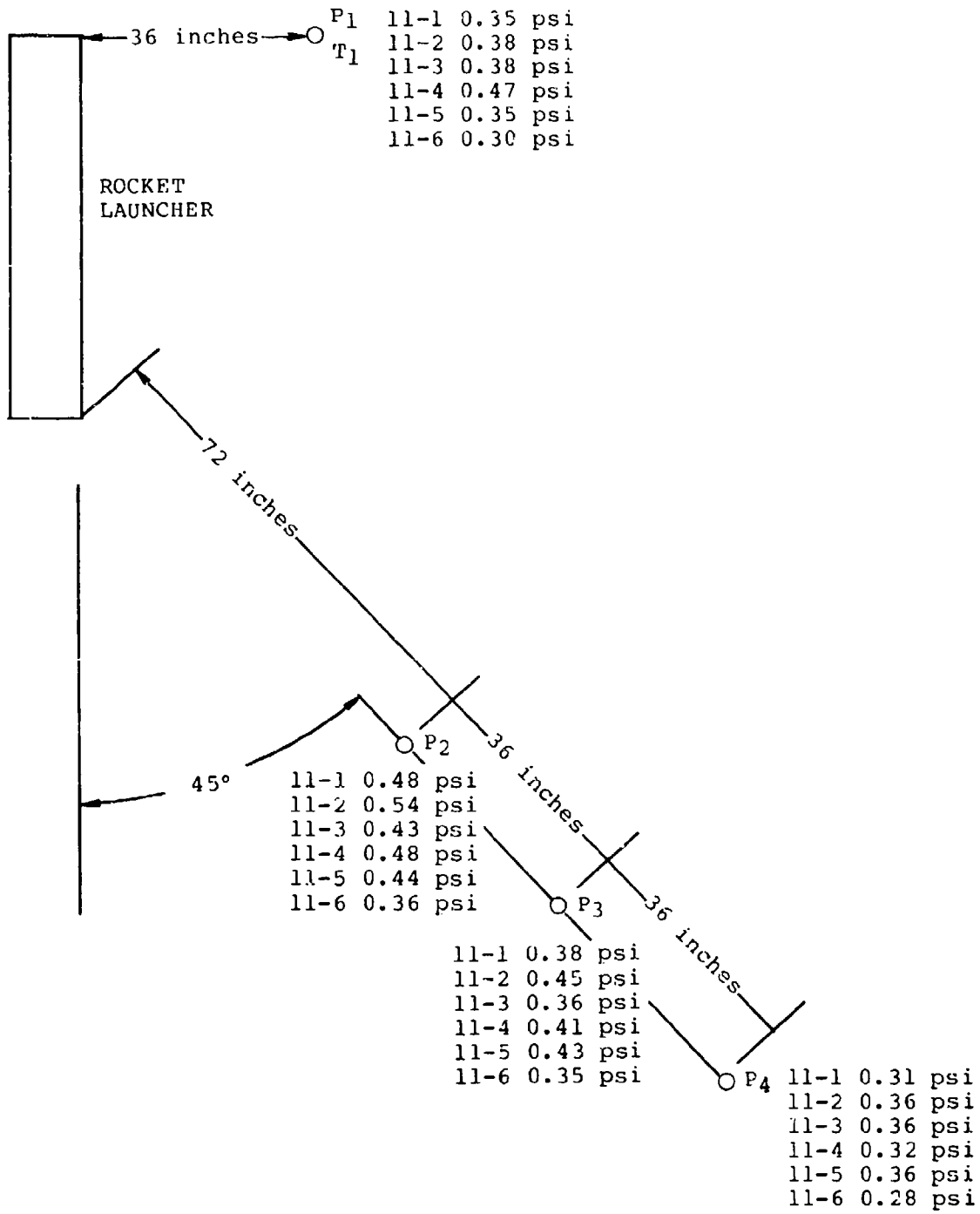

Figure 11. 2.75 inch rocket plume pressure test, MK40 motor ripple fire pressure map.

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